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ABSTRACT

The Sisters in Science program seeks to increase elementary school girls' interest and achievement in science and mathematics, to create a more positive learning climate for minority school girls and their families on academic and community/social levels, and increase the knowledge base and understanding of parents with respect to their influence in promoting girls' interest and achievement in science and mathematics. This paper reports on how 577 fourth grade girls in year one of the program and 627 fourth and fifth grade girls in year two of the program changed their interest and achievement in science and mathematics. Findings show that the girls started the program with positive attitudes and perceptions of science and about science career possibilities. The girls did significantly ($p<.001$) increase their science and mathematics skill levels after having participated in the program in both years one and two. It could be stated that the girls' achievement scores on the skills test increased significantly because the girls' attitudes and perceptions were positive before program implementation. (Contains 54 references.) (Author/ASK)

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The Sisters in Science Program: Building Girls' Interest and Achievement in Science and Mathematics

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Abstract

The Sisters in Science program seeks to increase elementary girls' interest and achievement in science and mathematics, create a more positive learning climate for minority school girls and their families on academic and community/social levels, and increase the knowledge base and understanding of parents with respect to their influence in promoting girls' interest and achievement in science and mathematics. This paper reports on how 577 fourth grade girls in year one of the program changed their interest and achievement in science and mathematics and on 627 fourth and fifth grade girls in year two of the program changed their interest and achievement in science and mathematics.. Findings show that the girls started the program with positive attitudes and perceptions of science and about science career possibilities. The girls did significantly ($p < .001$) increase their science and mathematics skill levels after having participated in the program in both years one and two. It could be stated that the girls' achievement scores on the skills test increased significantly because the girls' attitudes and perceptions were positive before program implementation.

The Sisters in Science Program:
Building Girls Interest and Achievement in Science and Mathematics

INTRODUCTION

Shirley M. Malcolm, of the American Association for the Advancement of Science (AAAS), said in her keynote address at the American Association of University Women (AAUW) conference "Girls Succeeding in Science, Math, and Technology: Who Works and What Works,"

> The effort to equalize educational opportunities for girls is far from complete. She notes, Unlike some other nations, female students in the United States are legally guaranteed access to math and science courses. While our legal barriers to this education have been removed, there are often still barriers we face, these are 'barriers of the mind (Malcolm, 1997).

Many barriers still exist that prevent females from participating fully in science and mathematics throughout their lives. The organizational characteristics of science and mathematics play important roles in diminishing the achievement of females in these disciplines (AAUW, 1990, Bleier, 1984; Harding, 1986; Kahle & Meece, 1994; Keller, 1985, 1986). Other researchers agree that females perceptions about science and mathematics act as barriers to their expressing interest in science and mathematics in school (Baker & Leary, 1995; Kelly, 1985; Shroyer, Powell, & Backe, 1991). Also, the perception that science and mathematics are masculine domains discourages females from choosing science and mathematics related careers (Kelly, 1985).

Researchers have also found that while both boys and girls enjoy math and science in elementary school, girls' interest and confidence in their abilities to excel in these areas declines sharply during adolescence. This is particularly true among females from economically and educationally disadvantaged families who have limited access to

educational resources and are often forced to cope with stressful life experiences (Mullis & Jenkins, 1988; Schibeci & Riley, 1986; Simpson & Oliver, 1990; Vetter & Babco, 1989; Ware & Lee, 1988). For example, the AAUW's survey "Shortchanging Girls, Shortchanging America" (1992) reported that the percentage of girls who said they enjoyed math dropped from 81% in elementary school to 61% in high school.

The report found that girls were frequently discouraged from exploring fields such as math, science, and technology; often unintentionally, by parents and teachers who steered them toward traditional female occupations. For example, the National Science Foundation reported that women made up about half of those working in the social sciences, but accounted for only 8 % of the nation's engineers. The AAUW report also uncovered a strong link between female students' confidence in their mathematics and science abilities and their overall self-esteem.

The study noted, "As girls learn, they are not good at these subjects, their sense of self-worth and aspirations for themselves deteriorates." Similarly, the AAUW research found that both girls and boys "who like math and science have higher self-esteem, greater career aspirations, and are more likely to hold onto their dreams. Therefore, it is imperative to continue to instill positive accessible images about science and mathematics in the minds of girls. Positive perceptions will in turn lead to greater female participation in science and mathematics with respect to academic endeavors and career aspirations.

Other research on gender inequity in science and mathematics focuses on the classroom environment. Studies have suggested that within classrooms, males and females receive a very different education (Jones & Wheatley, 1990). Girls have less exposure to science equipment than do boys. Girls also become less active in science classes as they progress through the grade levels (Klein, 1989).

Teachers' beliefs about students' abilities affect the manner in which female students operate in the classroom (Shepardson & Pizzini, 1992). Jones and Wheately (1990) looked at a variety of teacher behaviors during science instruction. They concluded that the manner in which the teacher praised students, responded to call outs, warned students, and questioned students differed by gender.

Female students also tend to differ from their male cohorts in their receptivity to and participation in science education. It has been noted that female students contribute less often to classroom discussion than their male classmates do. In fact, girls' conversations and the matters with which they concern themselves (i. e., interactional issues) are different from those of boys (Theberg, 1993). Finally, science education, is often competitive and individualistic, counteracting female learning styles that are more cooperative and interdependent in nature. Shakeshaft (1995) says that teachers have expectations that simply exclude girls and lead to lower participation and achievement by them.

Girls' perceptions of science also contribute to their inequity in achievement. Female students harbor stereotypical ideas about science and scientists. They often feel that science is a male dominated field (Hammrich, 1996). A meta-analysis (Weinburg, 1995) of the literature on gender difference in students' attitudes toward science as well as the correlation between students' attitudes about science and their achievements in science concluded that boys are more positive about science. Also, positive attitudes about science result in high achievement (Weinburgh, 1995).

Reformists believe that fostering a safe and nurturing environment, promoting problem-solving skills, creating collaborative experiences, using hands-on learning and allowing for open discussion about gender stereotypes are essential to encourage female students' success in the classroom (Allen, 1995; Mann, 1994).

Boland (1995) offers a set of strategies to promote gender equity in science and mathematics classrooms:

1. Set goals
2. Accept more than one right answer
3. Create equitable turn taking and use peer tutoring
4. Link math with careers in science
5. Display images of females and males in career roles
6. Assign tasks equally
7. Monitor groups for equity
8. Vary teaching techniques
9. Tap students learning styles
10. Encourage problem solving
11. Explore career options
12. Utilize cooperative learning styles

Other researchers address the issue of inequity in the classroom by recommending gender-sensitive instruction. In order to create a gender-sensitive learning environment, it is necessary for educators to confront issues pertaining to girls and their education rather than merely equalizing the treatment of males and females (Martin, 1996). Martin (1996) offers several strategies to ensure a gender-sensitive classroom: (a) utilize female-appropriate teaching, learning strategies and approaches to science; (b) address the needs and experiences of girls; (c) emphasize the importance of the social dynamic in the construction of the classroom environment; (d) acknowledge the contributions and barriers of women in science; (e) incorporate the impact of private and personal aspects of girls' lives on their educational experiences; and (f) remove the barriers that prevent girls from pursuing careers in science.

The female-friendly instructional strategies, recommended by Martin (1996), are essential to science learning for girls. Constructivism, an epistemological perspective of knowledge acquisition, serves as the foundation for many of the aforementioned suggestions regarding science and mathematics education reform. Constructivism is an approach to learning. Constructivists believe that children learn by doing. Learning involves changing pre-existing schema using new information acquired through varied experiences (Driver, 1995). In the constructivist framework, learning is both social and dialogical in nature. That is, as human beings interact with objects in their surroundings and with each other they construct mental models of their environment. The constant interaction of human and environment creates learning about the world (Driver, 1995).

Driver (1995) suggests that learners need to be given access to physical experiences as well as concepts and models of conventional science and mathematics. Science and mathematics instruction should consider the learners' individual conceptions, as well as their purposes and ideas, which can differ for each socially constructed group, particularly, females. Finally, teachers need to present experiences that enable students to make mental connections to pre-existing events.

The "Science for All Americans" (American Association for the Advancement of Science, 1985) report extends Driver's list by suggesting that students should have opportunities to: express themselves in oral and written form, work in teams, solve

problems, question, explore and discover concepts, use authentic tools, and learn about related professions and professional contributions to the field.

Declining interest in science and mathematics among females is additionally affected by experiences outside of school. Many females receive little or no reinforcement of their initial interest in science and mathematics from their families or social environment (AAUW, 1992). Research has reported that females and males have vastly different science and mathematics related experiences inside and outside the school (Kahle & Lakes, 1983; Linn, 1990; Rosser, 1990; Sjoberg & Imsen, 1988). Indirect and direct experiences that contribute to such difference include playing with scientific games and toys (Casserly, 1980; Hilton & Berglund, 1974), participating in science and mathematics activities at home (Kahle & Lakes, 1983; Mullis & Jenkins, 1988), taking science related field trips (Kahle & Lakes, 1983), parents' stereotypic behavioral expectations (Hoffman, 1977; Morgan, 1992), expectations for independence (Block, 1978; Hoffman, 1972), and parents' educational and vocational aspirations (Adelman, 1991; Brody & Fox, 1980).

Some females succeed academically in science despite the adverse circumstances (Bailey, 1996). Research has shown that when male and female high school seniors take the same amount and kind of science courses, females tend to outperform males (Adelman, 1991; Kahle & Meece, 1994; Mullis and Jenkins, 1988). Research suggests that it is not that females cannot and do not have the ability to succeed in science, but rather that obstacles arise in recruiting and retaining females in the science workforce (Kahle & Meece, 1994).

It seems logical to expect that females' positive attitudes toward science are fostered by instructional methods, role models, and peer and social factors inside and outside of the school. Research has documented that these factors play a significant role in promoting success in science for females (Bleier, 1984; Harding, 1986; Kahle & Meece, 1994; Keller, 1985, 1986).

PROGRAM DESCRIPTION

Rationale

In the context of broadening the concept of teaching and learning for all students by uniting the active participation of parents and intergenerational role models with other factors that promote females' success in science, Temple University's College of Education and Center for Intergenerational Learning developed the *Sisters in Science (SIS)* program, which is based on an *Experimental Project for Women and Girls in Science, Mathematics, and Engineering*, a program sponsored by the National Science Foundation (NSF). SIS is one of over 40 science education programs for Women and Girls, sponsored by NSF. NSF is one of several government-funded agencies established to address gender inequality in science and mathematics education.

Funding for programs like SIS has become available via the passage of legislation like Title IX of the Education Amendments Act. Passed in 1972, Title IX was enacted to address the inequities in educational programs receiving federal dollars. In 1974, the Women's Educational Equity Act was passed. It expanded math, science, and technology programs for females. In 1994, a package of gender-equity provisions was included in the Elementary and Secondary Education Act. Among the provisions was the creation of teacher training activities that work to eliminate inequitable practices and to develop programs to increase girl's participation in math and science (Parkay & Hardcastle-Stanford, 1998).

The SIS program efforts are consistent with the call for systemic educational reform that recognizes gender related learning style differences in science and mathematics (Tamir, 1988 & Versey, 1990). As the SIS program addresses the call for national reform, it is also in line with local science and mathematics education reform. When the SIS program was developed, it was founded to supplement recent initiatives introduced by the Philadelphia School District's Children Achieving Agenda. In addition, the program was also seen as a complement to currently functioning National Science Foundation initiatives in Philadelphia (e.g. the Urban Systemic Initiative). Thus, it can be stated that the SIS program is a vehicle for both local and national reform in science and mathematics education.

SIS is a two-year intervention designed to address the achievement inequities in mathematics and science for females. In year one, fourth-grade female students, their teachers, and families participate in the program. In year two, the fourth graders continue to participate with their fifth grade teachers. A new group of rising fourth grade girls begins the first year of the program in anticipation of participation in the two-year intervention

The SIS program provides fourth and fifth grade girls with cooperative interdependent science exploration. The rationale is that when girls are allowed to work in a manner that is intrinsic to their collective learning style (i.e., with the manipulation of materials) learning will occur (Rosser, 1990). Additionally, the program's designers are interested in the reformation of girls' perceptions of science education and science as a career option via reflective discussion as well as hands-on experience with science. At the core of the design is a program of research on fostering young females' positive attitudes toward science through building connections among schools, parents, and the community.

The program also provides support for parents and professional development opportunities for in- and preservice teachers. In this intergenerational program women who are currently employed in and retired from careers in science, engineering, and mathematics, and female university students who are pursuing careers in science and science education, serve as role models for the girls and share life and work experiences. In addition to acting as individual and small group mentors, the role models also serve as resources for teachers on a continual basis and facilitate student and teacher understanding of how classroom experiences translate into employment experiences in urban environments.

Goals and Objectives

The SIS program offers a multileveled intervention centered on the constructivist learning model. To this end, cooperative exploratory hands-on science and mathematics education tasks along with self-reflection are employed to facilitate learning. Within this framework of constructivist learning, the SIS program was designed to provide instructional methods that demasculize and demystify science and mathematics, promote women role models and career information, and allow for active involvement in a

"female friendly" environment. While girls are "doing" science and mathematics their self-confidence and self-perceptions of their ability to do science and mathematics is enhanced (Hammrich, 1997).

In year one and two the program seeks to:

1. Improve fourth and fifth grade females' attitudes toward, interest in, and achievement in science and mathematics;
2. Create a more positive learning environment for fourth and fifth grade females and their families on academic and community/social levels; and,
3. Increase the knowledge base and understanding of the influence parents and teachers have in promoting females' interest in science.

Program Components

In order to attain these goals, the SIS program has three major components in year one: (a) an in-school constructivist and gender-sensitive science program; (b) an after-school enrichment program; and (c) a "city rivers exploration" summer camp. In year two fifth grade grade girls participate in a Saturday academy program.

The components of the program work in concert to provide 4th and 5th graders with a physical environment that is both psychologically, emotionally and socially safe and accessible to all students. The activities themselves engage students in instructional experiences that challenge everyone involved. The activities clearly connect subject matter to real-world issues that are culturally relevant to students. Whereas in the past, "a curriculum" has often meant a set of answers to be transferred from teacher to student, the curriculum as outlined in the SIS program is a set of questions to be posed to a class (Skilton Sylvester, 1997). In this way, the process of inquiry is co-constructed by the students and teachers and fosters a true community of learners. During each component of the program, students take responsibility for generating and gathering "data," posing questions and problems, generating possible explanations and proposing methods for evaluating the best explanations. Across all of the events, teacher, parents, volunteers, and Temple University students are providing a level of mentoring that extends the students learning base beyond the walls of the classroom.

The in-school program was conducted for two hours a week for each classroom at each of the six schools. Classroom activities focused on the urban environment and used

gender sensitive approaches to teaching science/mathematics. As part of the program's teacher enhancement component, Students in science education methods courses at Temple University facilitated the program sessions with the classroom teacher. The preservice teachers' coursework explored gender-equity issues in the classroom, the constructivist approach to learning, and the community service learning concepts presented in the program.

The after-school program was conducted from 3:00-4:30 p.m. one day per week in each of the six schools. The program coordinator facilitated the after-school component with assistance from graduate and undergraduate elementary education students and members of the intergenerational volunteer corps. The after-school component extended the classroom activities by focusing on the concepts of systems, constancy/change, model, and scale. The students also engaged in reflection activities designed to help them better understand their personal learning, challenge stereotypical notions about science, and develop critical thinking skills. These reflective activities included writing and interactive discussions.

The summer program was conducted for two weeks during July to reinforce learning that occurred during the academic year. Fourth grade females spent two weeks exploring the city rivers. Activities included taking four field trips to environmentally focused sites in the area, mapping local waterways, creating model rivers, and designing improvement plans to prevent the city rivers from becoming polluted. At the end of the summer program, the girls shared their learning with their families and other students from neighborhood elementary schools.

The Saturday academy program was conducted on Saturdays for four hours at a local site. Activities focused on expanding what the fifth grade girls learned during year one of the intervention. The fifth grade activities were designed to introduce a more technology focus and a sport component. Sample activities that the girls participated in were taking apart and putting back together computers, developing web pages, and learning how to play tennis and fencing and learning the science and mathematical principles behind each sport. The fifth grade activities tied mathematics, science, and technology together.

Each of the central studies of the SIS program is structured around one or more central questions, which provides a focal point for the classes' inquiry. Each central study is woven by both unifying themes and cross-cutting competencies. The four unifying themes are: systems, models, scale, and constancy/change. The unifying themes constitute those skills that allow people to play effective roles in the community. For example, in the context of the classes' study of city rivers, students learn about *systems* as they study the water cycle. Along the way, the students discover the three states of matter: liquid, solid, and gas, a lesson which is fundamental to understanding *constancy and change*. Students learn about *models* as they create their own rivers. In creating their model of the river, students need to utilize the principal of *scale*.

The five cross-cutting competencies are: participatory citizenship, communication, multicultural competencies; problem-solving; and school-to-career readiness, technological literacy (School District of Philadelphia, 1996). In the study of city rivers mentioned above, students ask the question: "How do the city rivers get clean so that people can drink the water?" In searching for answers to this question, students engage in visiting a city water treatment plan, researching (with the help of the Internet) ways of making drinking water safe, and writing local scientists for their answers and suggestions. This lesson involves *problem solving, technological literacy, participatory citizenship* , and *communication*. We might also ask, "How do different groups of people make the best of the city drinking water?" This might lead to learning about different ways of life of different ethnic groups, a lesson that "culture" is about values, beliefs and practices that guide our daily lives -- helping students develop *multi-cultural competencies*.

PROGRAM EVALUATION

Method

Conducted at six schools located in inner-city Philadelphia, the program's first year involved 577 fourth grade girls in six elementary schools, an intergenerational corps of 10 women volunteers, 182 undergraduate elementary education students, and nineteen inservice teachers. Year two involved 627 fourth and fifth grade girls in the six elementary schools, an intergenerational corps of 20 women volunteers, and 189 undergraduate elementary education students, and thirty one inservice teachers.

In an attempt to measure the relative effectiveness of the SIS program efforts to increase the interest, achievement, attitude and awareness of girls in science and mathematics knowing, a pre-post test design was employed. According to Agnew & Pyke (1994) a pre-post design is more effective than an 'after the fact' design which stretches back in time. A pre-post design answers the question, 'I wonder what will happen if. However, it doesn't account for the many factors that may mediate the differences from pre to post such as maturation, other interventions, and biased testing. Qualitative survey data was also collected to measure the relative effectiveness on parental contribution and teacher awareness. This was done to simply take a preliminary look at changes as the possible result of the SIS intervention.

Pre-post test instruments regarding changes in participating students' science and mathematics skills, attitudes toward science and mathematics in school, and preceptions of scientists three instruments were administered to students at the start of the first and second in-school sessions and again during the final two sessions of the of the SIS program. To increase girls' attitude, interest, and awareness toward science and mathematics were measured by a single questionnaire. The instrument contains 30 items each with a 5-point likert response scale (strongly disagree, disagree, neutral, agree, and strongly agree). This Science Attitude Scale instrument was adapted from the (Meyer & Koehler,1988) scale to reflect the cognitive capacities of young learners. The students perceptions were measured by using the Draw a Scientist instrument (Mason, Kahle & Gardner, 1989).

To measure the increase in science and mathematics achievement a science process skills and mathematics skills instrument specific to the fourth grade and tied to the curriculum for fourth graders in the Philadelphia Schools was employed. These two instruments were validated in one or both of two ways. The skills instruments were developed from material contained in the current curriculum documents of the School District of Philadelphia, involved skills deemed to be critical, and thus were held to have content validity. In addition, reliability figures were calculated on a test-retest correlation model, and confirmed using the Kuder-Richardson (formula 22) procedure. Another measure of achievement was to review the Stanford Nine scores at the fourth grade level.

Results

The year one data set for the preassessment attitude comprised 414 completed questionnaires, representing 185 boys and 229 girls in the fourth grade. The data set for the attitude post assessment comprised 450 completed questionnaires, representing 194 boys and 256 girls. These students represented six Philadelphia Schools in 19 classes. The responses were scored 1 = strongly disagree, 2 = disagreed, 3 = neutral, 4 = agree, 5 = strongly agree. Scores above 3.0 indicate the students agreed or strongly agreed with the statements on the subscale. Table 1 shows that there was no significance found pre to post between the girls scores. However, when compared to the 185 boys who completed the questionnaires, the girls had significant difference on means scores pre and post on the attitude scales across all scales.

Insert Table 1 about here

The fact that the girls attitude scores did not change significantly pre to post might indicate that the girls' attitudes were high before program implementation. What is interesting to note is that before implementation of the program the girls had significantly higher attitude scores than the boys.

Year two data set for the preassessment attitude comprised 412 completed questionnaires for the fourth grade students, representing 205 boys and 207 girls and 399 completed questionnaires for the fifth grade students, representing 184 boys and 215 girls. The data set for the attitude post assessment comprised 423 completed questionnaires for the fourth grade students, representing212 boys and 211 girls and 375 completed questionnaires for the fifth grade students, representing 167 boys and 208 girls. These students represented six Philadelphia schools in 31 classrooms. The responses were scored 1 = strongly disagree, 2 = disagreed, 3 = neutral, 4 = agree, 5 = strongly agree. Scores above 3.0 indicate the students agreed or strongly agreed with the statements on the subscale. Table 2 shows that there was no significance found pre to post between the girls scores in the fourth grade. However, when compared to the fourth grade girls the fifth grade girls attitude was significantly higher. This maybe the result that these fifth grade girls participated in fourth grade and chose to continue in the fifth

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grade of the program, therefore, they already had a high interest in both the program and in science.

Insert Table 2 about here

The students perceptions for year one and two were measured by the Draw a Scientist test (Mason, Kahle, & Gardner, 1989). The occurrence of characteristics for each drawing were counted (see Table 3). On both the pre and post tests for year one a majority of the girls (71% and 71% respectfully) drew female scientists. There was no significant change. Likewise with the boys on the pre and post tests a majority (82% and 92% respectively) drew male scientists. Again there was no significant change. What is interesting to note is that both the girls and boys drew scientist that represented their own gender which is contradictory to the literature on perceptions.

In year two we found that the pictures were more androgous and therefore hard to decide if the drawings depicted a male or female scientist. However, more girls drew more female scientists pre and post at both the 4th and 5th grade level than the boys.

Insert Table 3, 4, & 5 about here

For year one there were 486 complete sets of data for the science/mathematics skills for the Fall 1997 test administration. There were 418 complete sets of data were analyzed for the Spring 1998 test administration. Pre and post mean scores were obtained on both the boys and girls in order to look at differences between the girls who were involved in the program and boys who were not (see Table 6). The seven skill totals were computed along with the total test score means. ***Note: Year two data is still being analyzed so this at this time this paper does not contain the skill data for year two.***

Insert Table 6 about here

Analysis of variance was used as the statistical test for the purpose of revealing the extent of change from pre to post test for the science/mathematics skills test. The analysis was conducted four ways: pre and post for the boys changes, pre and post for the girls changes, girls pre versus boys pre, and girls post versus boys post.

Results were also obtained on the Stanford Nine national test. All fourth grade classrooms take this national test each year. There was a gain on the scores for each school for each year of the intervention. No statistical test was run to see if their was a significant difference on the gain scores (see Table 7).

Insert Table 7 about here

DISCUSSION

Summary of Findings

Results of the Science Attitude Scale showed that the girls attitudes toward science and the possibility of pursuing a career involving some aspect of science and/or mathematics were positive before program implementation. Anecdotal information regarding the girls revealed that while they enjoyed science and perhaps someday wanted to become a doctor or have a career in science, they were not aware that it was necessary to take science classes in the future. Therefore their attitudes did not match their understanding of how science courses fit into their eventual career path. However, their expressed positive attitude towards science is consistent with the research that states girls at this age level tend to enjoy science (AAUW, 1992). In year two the fifth grade girls attitude continued to be positive and significantly higher than the fourth grade girls attitude. This maybe due to the fact that these fifth grade girls participated in fourth grade and chose to participate again in year two in the fifth grade. What remains to be documented is if the girls will continue to have positive interest in year three of the program.

Results also showed that the girls had significantly higher attitudes both pre and post in comparison to the boys attitudes. Since the girls had significantly higher attitudes than the boys before program implementation suggests that the program alone cannot attest to the girls higher attitudes. Also it is possible that parental expectations could

account for girls high attitudes. However, further questions remain as to what other factors are generating girls high attitudes in science and why are girls attitudes higher than the boys attitudes before program implementation.

Regarding girls perceptions of science, the girls tended to draw female scientists both pre and post. This was also evident with the boys who drew male scientists. There seems to be a strong affiliation toward same gender role models between the girls and boys. This could be a result of family or community influence but it is only speculative. This is a question that needs to be explored further.

Results from the science/mathematics process skills instrument in year one indicated a mixture of statistically significant changes for the boys and girls participating in the program. This was a combination of small losses and small gains for the six schools involved. We entered each school with a commitment to service all 4th grade classrooms. Therefore no control groups existed within the schools. In other words no "control vs. experimental' group analysis was warranted. Clearly, to the extent that the instrument was appropriate to the problem, a majority of the outcomes did meet the expectation of an increase in the science process skills. Of the skills tested, all of them appeared in the fourth grade Philadelphia curriculum.

There was a significant change from pre to post for both the boys and girls for skills 1 - observation, 9-12 -recognition of variables in an experimental procedure, graphing (using bar graphs), and interpretation of graph results, skills 3 &4 - classification, skill – 5 measuring using non-standard units, skill 7 &8 - observing and predicting. The two skill items that were nonsignificant pre to post for both the boys and girls were skill 2 - symmetry and skill 6 - measuring with non standard units. When comparing the girls and boys pre and post scores, significant differences ($p < .001$) was identified for two skill levels for the pre comparison, skill 1 and on the total test, and one for the post comparison, skill 3,4.

Achievement was also measured using the grade four Stanford Nine science scores. All six schools 4th grades tested at each school saw an increase in their scores over the years of SIS intervention. No statistical test was run on the data. Stanford Nine scores are published by the School District for public consumption each year. In year one there was a range of growth scores for the six schools from 1.2 to 14.9 with the average gain

score 7.9 overall. In year two the range of increase for the schools was from 1.2 to 35.6 with the average gain score of 8.8. The rate of change was 50% higher for SIS than non-SIS 4th grade schools in the district. While it is not possible to single out the SIS intervention as the only contributing factor to the increase in scores, Principals at all schools were very generous in their praise for SIS intervention being a contributing factor for their schools' score increases.

Implications

The SIS program seeks to increase elementary girls' interest and achievement in science and mathematics, create a more positive learning climate for minority school girls and their families on academic and community/social levels, and increase the knowledge base and understanding of parents with respect to their influence in promoting girls' interest and achievement in science and mathematics. Findings to date show that the girls started the program with positive attitudes and perceptions of science and about science career possibilities. The girls did significantly increase their science and mathematics skill levels after having participated in the program. It could be stated that the girl's achievement scores on the skill test increased significantly because the girl's attitudes and perceptions were high before program implementation. If their attitudes and perceptions were low to begin with perhaps their skills would not have increased significantly.

There are several limitations that may have hindered the outcome of program results. First of all there was no control group comparison; therefore, other factors unknown to the researchers could have mediated the results. In the future, there will be made allowances to include a control group. A second limitation could be a "Hawthorne" like effect. Prior to program implementation there were no hands on, integrated science and mathematics experiences taking place in the six schools. Year two will provide evidence for or against sustained improvements. Another limitation was that matched sampling was not employed pre to post. This might have yielded more dramatic differences in progress from fall to spring. Lastly, school populations are often transient. Therefore, the fall sample may not have matched the spring sampling. In the future random sampling across all instruments may be warranted.

In the successive years of the program, the researchers will attempt to look at longitudinal affects on the girls' attitudes, perceptions, and achievement levels. Since, in

year one, the girls held positive attitudes towards science before program implementation it may warrant a closer look at the cultural and familial factors that my have contributed to the girls attitudes. Researchers will also attempt to document more substantive qualitative data to shed more information on the achievement gains achieved in year one. While year one of the program has been promising, many more questions still remain and new ones have developed. In an attempt to answer these questions, the researchers will look for ways to improve program implementation. What became evident in year one of program implementation was that (a) parental behavioral expectations for their daughters have important implications for females' interest and achievement in science and mathematics; (b) intervention programs that are specifically designed to include role models have a strong and positive impact on females' achievement in science and mathematics and assist females to identify with science and mathematics as possible areas for study or employment; (c) program interventions evolve in stages of development, growth, and change. In order to promote the sustained success of females in science and mathematics, there must be a conscious effort to provide support for collaboration among schools, parents, and the community as ideas for useful strategies are developed, implemented, and evaluated.

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Table 1. Year One: Science Attitudes Scale Mean Scores (Across All Scales- fourth grade)

	Females	Males
Pre	3.88*	3.45
Post	3.96*	3.46

* significant difference $p < .05$

Table 2. Year Two: Science Attitudes Scale Mean Scores (Across All Scales – fourth and fifth grades)

	Females		Males	
	4th	5th	4th	5th
Pre	3.71	4.03*	3.66	3.81
Post	3.88*	3.99*	3.86*	3.86

* significant difference $p < .05$

Table 3. Year One: Frequency of Responses for Draw A Scientists Test (fourth grade)

	Fall '97 (N=477)		Spring '98 (N=433)	
	Male n=211	Female n=266	Male n=194	Female n=239
Drawing Male	174	50	179	48
Drawing Female	9	189	8	170
Drawing Both	3	10	2	14
Can't Determine	25	17	5	7

Table 4. Year Two: Frequency of Responses for Draw A Scientists Test (fourth grade)

	Fall '98 (N=)		Spring '99 (N=)	
	Male n=208	Female n=186	Male n=181	Female n=199
Drawing Male	28%	27%	72%	12%
Drawing Female	2%	30%	8%	57%

Table 5. Year Two: Frequency of Responses for Draw A Scientists Test (fifth grade)

	Fall '98 (N=)		Spring '99 (N=)	
	Male n=180	Female n=214	Male n=150	Female n=179
Drawing Male	38%	9%	36%	13%
Drawing Female	2%	27%	3%	31%

Table 6. Means for Skills Test

		Fall '97 (N=486)		Spring '98 (N=418)	
Skill	Max. Points	Male n=210	Female n=276	Male n=192	Female n=226
1	5	4.41	4.46**	4.48*	4.60*
2	4	3.53	3.66	3.71	3.69
3/4	4	2.71	3.00	3.12*	3.28* **
5	4	1.49	1.58	2.14*	2.26*
6	3	.95	.97	.88	.96
7/8	6	3.28	3.43	3.74*	3.72*
9-12	12	2.98	2.95	4.40*	4.46*
Total	38	19.44	20.21**	23.09*	24.40*

* significant difference pre to post ($p<.00$)

** significant difference pre to pre with girls being favored ($p< .00$)

Note: Skill 1 – observation, Skill 2 – symmetry, Skill 3 & 4 – Classification, Skill 5 – measuring, Skill 6 – averaging, Skill 7 & 8 – predictions, Skill 9-12 – experimental procedures.

Table 7. Stanford Nine Point Scores for Science

Schools	1996-1997	1997-1998	1998-1999
Childs	71.3	72.5	65.7
Clymer	43.9	51.6	79.7
Dunbar	56.5	63.5	66.1
Ferguson	55	63	63.7
Morrison	70.5	79.2	81.9
Olney	62.6	77.5	78.9

*Note: Scores for Harrison Elementary were unavailable